PROCEEDINGS OF SCIENCE

Measurement of the charge ratio of atmospheric muons with the CMS detector

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A measurement is presented of the flux ratio of positive and negative muons from cosmic ray interactions in the atmosphere, using data collected by the CMS detector at ground level and in the underground experimental cavern. The excellent performance of the CMS detector allowed detection of muons in the momentum range from 5 GeV/c to 1 TeV/c. For muon momenta below 100 GeV/c the flux ratio is measured to be a constant $1.2766 \pm 0.0032(\text{stat.}) \pm 0.0032(\text{syst.})$, the most precise measurement to date. At higher momenta an increase in the charge ratio is observed, in agreement with models of muon production in cosmic ray showers and compatible with previous measurements by deep underground experiments.

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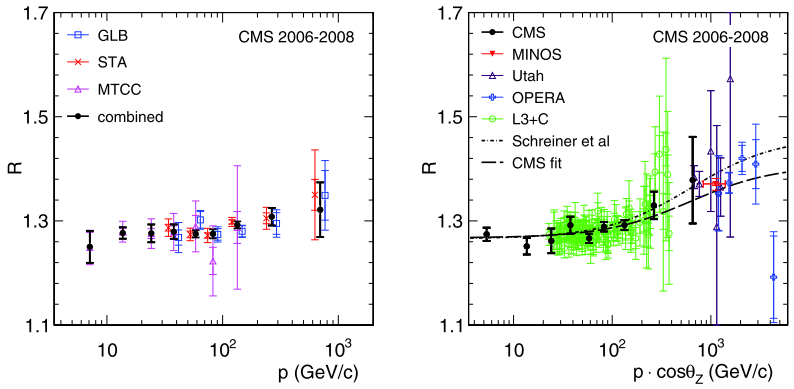

Figure 1: Charge ratio R as a function of muon momentum (left) and its vertical component (right). Various measurements and fits are superposed.

1. Dataset and measurement

The flux ratio R of positive to negative muons of cosmic ray interactions in the atmosphere is measured with the CMS detector [1]. The Measurement is based on $3.3 \cdot 10^5$ stand-alone muon track events taken with the muon drift tube chambers of the CMS detector at ground level in 2006 as well as $1.6 \cdot 10^6$ stand-alone muon events and $2.45 \cdot 10^5$ global muon events, requiring a match to the central tracking system of the CMS detector, in the underground experimental cavern in 2008. The underground measurements are corrected for muon energy loss in the material between earth's surface and the CMS detector. The muon momentum resolution is corrected by means of unfolding.

2. Results

In consistence with previous measurements (see Fig. 1) and with significant improvement in precision the charge ratio R is found to be constant below muon momenta of 100 GeV/c yielding

$$R = 1.2766 \pm 0.0032(\text{stat.}) \pm 0.032(\text{syst.}). \tag{2.1}$$

and below vertical muon momentum components of 70 GeV/c yielding

$$R = 1.2728 \pm 0.0039(\text{stat.}) \pm 0.040(\text{syst.}). \tag{2.2}$$

A rise of the charge ratio is seen (Fig. 1) above muon momenta of 100 GeV/c. The expected muon spectrum has been parameterised based on a pion kaon model [3]. In comparison to the fit of Schreiner et al. [4] a CMS fit over the entire $p\cos\theta_z$ region yields the fractions of all pion and kaon decays into positive muons of $f_\pi = 0.533 \pm 0.005$ and $f_K = 0.66 \pm 0.06$, respectively.

References

[1] CMS collaboration, JINST **3**, S08004 (2008).

[2] CMS collaboration, Phys. Lett. **B** 692, 83 (2010), CMS PAS MUO-10-001, CERN-PH-EP/2010-011, arXiv:1005.5332.

[3] T. Gaisser, "Cosmic Rays and Particle Physics", Cambridge University Press 1990.

[4] P. A. Schreiner et al., Astropart. Phys. **32, Issue 1**, 61 (2009).